

JC13 Rec'd PCT/PTO 19 MAR 2001

FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NO. PHN 17,556
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. Application No. (if known, see 37 CFR 1.5) <b>09/787457</b>
INTERNATIONAL APPLICATION NO. PCT/EP00/06816	INTERNATIONAL FILING DATE JULY 17, 2000	PRIORITY DATE CLAIMED JULY 22, 1999
TITLE OF INVENTION METHOD OF MANUFACTURING A MAGNETIC TUNNEL JUNCTION DEVICE		
APPLICANT(S) FOR DO/EO/US DERK JAN ADELERHOF, REINDER COEHOORN, JOANNES BAPTIST ADRIANUS DIONISIUS VAN ZON		
Applicant(s) herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.		
2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.		
3. <input type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).		
4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.		
5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c)(2)) a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> has been transmitted by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).		
6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2))		
7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> have been transmitted by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made.		
8. <input type="checkbox"/> A translation of the amendment to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).		
9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).		
10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).		
Items 11. to 16. below concern document(s) or information included:		
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.		
12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.		
13. <input type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND OR SUBSEQUENT preliminary amendment.		
14. <input type="checkbox"/> A substitute specification.		
15. <input checked="" type="checkbox"/> A change of power of attorney and/or address letter.		
16. <input checked="" type="checkbox"/> Other items or information: a) AUTHORIZATION PURSUANT TO 37 CFR 1.136(a)(3) b) TWO (2) SHEETS OF FORMAL DRAWINGS c) APPLICATION AS PUBLISHED (WO 01/07926)		

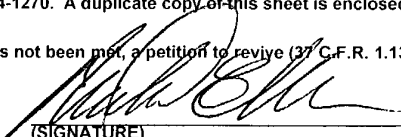
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I hereby certify that this paper and/or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington D.C. 20231

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Typed Name                      Signature

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) <b>09/787457</b>		INTERNATIONAL APPLICATION NO. PCT/EP00/00247- <b>EP0006816</b>		ATTORNEY'S DOCKET NUMBER PHN 17,285	
17 [X] The following fees are submitted: BASIC NATIONAL FEE (37 C.F.R. 1.492(A)(1)-(5)): Search Report has been prepared by the EPO or JPO \$940.00 International preliminary-examination fee paid to USPTO (37 C.F.R. 1.482) \$720.00 No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)) \$760.00 Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO \$970.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$ 96.00 ENTER APPROPRIATE BASIC FEE AMOUNT = \$970.00				CALCULATIONS (PTO USE ONLY)	
Surcharge of \$130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	12 - 20 =		X \$ 18.00	\$	
Independent claims	1 - 3 =		X \$ 78.00	\$	
MULTIPLE DEPENDENT CLAIMS (if applicable)			+ \$260.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$970.00	
Reductions by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 C.F.R. 1.9, 1.27, 1.28)				\$	
SUBTOTAL =				\$	
Processing fee of \$130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). \$40.00 per property +				\$40.00	
TOTAL FEES ENCLOSED =				\$1,010.00	
				Amount to be refunded	\$
				charged	\$
a. [ ] A check in the amount \$_____ to cover the above fees is enclosed.					
b. [X] Please charge my Deposit Account No. 14-1270 in the amount of \$1,010.00 to cover the above fees. A duplicate copy of this sheet is enclosed.					
c. [X] The Commissioner is hereby authorized to charge any additional fee, with the exception of the Base Issue Fee, which may be required, or credit any overpayment to Deposit Account No. 14-1270. A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: Corporate Patent Counsel Philips Electronics North America Corporation 580 White Plains Road Tarrytown, NY 10591					
DATE OF MAILING: <b>MARCH 19, 2001</b>				(SIGNATURE)  <b>Michael E. Marion</b> NAME	
				<b>32,266</b> (REGISTRATION NUMBER)	

Method of manufacturing a magnetic tunnel junction device.

The invention relates to a method of manufacturing a magnetic tunnel junction device, in which a stack comprising two magnetic layers and a barrier layer extending in between is formed.

5 The invention also relates to a magnetic tunnel junction device obtainable by means of such a method, a magnetic field sensor provided with such a device and a magnetic memory provided with such a device.

10 A device as described above is disclosed in WO-A 99/22368. The magnetic tunnel junction device known from said patent application comprises a first and a second magnetic layer, which layers are sandwiched with respect to an insulating intermediate layer and serve as electrode layers. As a transducing element, this device forms part of a magnetic field sensor provided with a magnetic yoke, in which the first magnetic layer is in direct contact with a part of the yoke. The first magnetic layer, likewise as the yoke, is formed from a soft-magnetic material. The second magnetic layer is a composite layer and comprises a  
15 ferromagnetic sub-layer and a pinning structure. The insulating intermediate layer constitutes a tunnel barrier.

In the known magnetic tunnel junction device, one of the magnetic layers, namely the soft-magnetic layer, therefore also serves as a flux guide. To prevent detrimental effects on the magnetical properties of this layer, such as domain wall formation due to  
20 irregularities in the surface of the soft-magnetic layer facing the tunnel barrier, it is desirable that only the other magnetic layer, i.e. the second magnetic layer, and possibly the barrier-forming intermediate layer, is, or are, structured.

It is an object of the invention to provide a method of the type described in the opening paragraph, comprising a process of structuring one of the magnetic layers, which  
25 process stops with certainty before the other magnetic layer is reached.

To achieve the object described, the method according to the invention is characterized in that one of the magnetic layers is structured by means of etching, in which, during etching, a part of the relevant layer is made thinner by removing material until a rest layer remains, whereafter the electrical resistance of the rest layer is increased by chemical

conversion. After performing the method according to the invention, a magnetic tunnel junction device is obtained in which one of the magnetic layers is structured and processed in such a way that unwanted electric currents in the structured layer obtained are inhibited during use. In principle, the other magnetic layer has remained unattacked.

5 In the method according to the invention, it is with certainty that the other magnetic layer is not reached, because the magnetic layer to be structured is not entirely etched off during said etching process in which use is made in known manner of a mask so as to shield a part of the magnetic layer to be structured, which is or may comprise a soft-magnetic layer. The rest of the etched part of this layer remaining after etching, referred to as  
10 the rest layer, is rendered poorly conducting by means of a chemical reaction, whereafter the structured magnetic layer, as well as the other magnetic layer, can be used as a magnetic electrode. Etching preferably takes place until the rest layer has reached a thickness of between 0 nm and 5 nm, in which process, for example, resistance measurements determine when the rest layer is reached. It has been found that the above-mentioned measures do not  
15 have any detrimental effects on said other magnetic layer; particularly, there is no detrimental influence on the magnetical properties of this magnetic layer. The method according to the invention also makes use of the advantage that the manufacturing margins are considerably wide when using non-selective etching techniques. If the last-mentioned layer is formed from or also from a soft-magnetic material, this layer is particularly suitable for use as a flux-  
20 guiding layer.

An embodiment of the method according to the invention is characterized in that the chemical conversion is effected by oxidation and/or nitridation. In this embodiment, the rest layer can be passivated in a simple manner by making use of known processes. An oxidation of the rest layer, in which material of the rest layer is converted into an oxide, is  
25 preferably realized by thermal oxidation, plasma oxidation or UV-assisted oxidation. A nitridation of the rest layer, in which material of the rest layer is converted into a nitride, is preferably realized by thermal nitridation or plasma nitridation. In the mentioned, known chemical processes, the desired oxidation or nitridation of the magnetic material of the rest layer can be obtained within a comparatively short time. If the barrier layer is an oxide layer,  
30 which is often the case, it will stop or decrease the oxidation in the rest layer at a given moment during performance of an oxidation process.

An embodiment of the method according to the invention is characterized in that physical etching is performed. Physical etching is understood to mean etching by means of a beam of electrically charged particles, such as sputter etching, ion milling and ion beam

etching. These known etching methods have proved to be eminently suitable for the method according to the invention.

An embodiment of the method according to the invention is characterized in that the magnetic layer to be structured is built up from, consecutively, a basic layer and a layer structure comprising at least a further layer for magnetic pinning of the basic layer. The basic layer may be a ferromagnetic layer, for example, of an NiFe alloy or a Co alloy, particularly a Co-Fe alloy, while the pinning layer structure may comprise one of the following possibilities: an anti-ferromagnetic layer of, for example, an FeMn alloy or an IrMn alloy; a hard-magnetic ferromagnetic layer of, for example, a Co alloy; an artificial anti-ferromagnetic structure comprising two anti-parallel magnetic layers separated by a metallic intermediate layer. Such a structure may be coupled to an anti-ferromagnetic layer of, for example, an FeMn alloy. If such a magnetic layer to be structured is formed, it is preferred to selectively etch the layer structure, particularly selectively chemically etch this structure before etching, particularly physical etching takes place, until the basic layer is reached. By making partly use of said selective etching, the structuring process in accordance with the method according to the invention can be performed within a shorter period of time. Selective chemical etching is a known etching technique.

It is to be noted that the method according to the invention implies a method of structuring a magnetic electrode layer of a semi-manufactured product of a magnetic tunnel junction device, in which the semi-manufactured product comprises an assembly of said electrode layer, a barrier layer and a further magnetic electrode layer. In the last-mentioned method, the structuring of the relevant layer does not influence the magnetical properties of the other magnetic electrode layer of the magnetic tunnel junction device, at least not in a detrimental sense. The special aspect of this method, in which etching is used, is that etching does not take place as far as the barrier layer of the magnetic tunnel junction device, but the etching process is stopped at such an earlier moment that a rest layer remains on the barrier layer. It is thereby ensured that, in spite of layer thickness variations and variations of etching methods, the magnetic electrode layer, which is not to be structured, is not etched. The barrier layer, which is an insulating layer, a layer having a low electrical conductance, or an electric layer, is usually only approximately 1 nm thick.

The magnetic tunnel junction device according to the invention, manufactured by means of the method according to the invention, has a magnetic layer structured by means of this method and another magnetic layer which may be or may comprise a soft-magnetic layer, which layer is usable as a flux guide. Such a soft-magnetic layer may be formed from,

for example, an NiFe alloy or a Co alloy such as a Co-Fe alloy. The soft-magnetic layer may also be built up from a number of sub-layers.

The magnetic field sensor according to the invention is provided with the magnetic tunnel junction device according to the invention. The magnetic tunnel junction device forms one or the transducing element of the magnetic field sensor according to the invention. This sensor may be used, inter alia, as a magnetic head for decoding magnetic flux originating from a magnetic information medium such as a magnetic tape or a magnetic disc; as a sensor in compasses for detecting the earth's magnetic field; as a sensor for detecting, for example, a position, an angle, or a velocity, for example, in automotive uses; as a field sensor in medical scanners; and as a current detector. Also the magnetic memory, particularly a MRAM, according to the invention is provided with the magnetic tunnel junction device according to the invention.

With regard to the claims, it is to be noted that various combinations of the embodiments mentioned in the dependent claims are possible.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1A shows diagrammatically a first intermediate product obtained from an embodiment of the method according to the invention;

Fig. 1B shows diagrammatically a second intermediate product obtained from said embodiment of the method according to the invention,

Fig. 1C shows diagrammatically a third intermediate product obtained from the embodiment of the method according to the invention,

Fig. 1D shows diagrammatically a fourth intermediate product,

Fig. 1E shows diagrammatically an embodiment of the magnetic tunnel junction device according to the invention, made in accordance with the described embodiment of the method according to the invention, and

Fig. 2 shows an embodiment of the magnetic field sensor according to the invention.

Fig. 1A shows a stack 1 of layers which comprises, in this example, a first magnetic layer 3 of a soft-magnetic material, such as an NiFe alloy, an insulating, poorly

conducting or dielectric layer 5, in this document also referred to as barrier layer, of, for example  $\text{Al}_2\text{O}_3$ , a second magnetic layer 7 built up in this example of a basic layer 7a of a soft-magnetic material, in this example an NiFe alloy, and a layer structure 7b comprising at least a further layer of an anti-ferromagnetic material such as an FeMn alloy. Alternatively, a hard-magnetic layer may be used as a second magnetic layer for the layer structure comprising the basic layer 7a and the layer structure 7b. During the method according to the invention, a shielding layer 9 of, for example, a photoresist, see Fig. 1B, is provided on the stack 1 shown. Subsequently, etching processes are used, in which the layer structure 7b is first etched selectively, particularly etched chemically, until the basic layer 7a is reached; see Fig. 1C. Subsequently, the basic layer 7a is etched, particularly etched physically, until a rest layer 7r of soft-magnetic material remains; see Fig. 1D. Alternatively, instead of two etching processes, it may be sufficient to use physical etching only, such as sputter etching. Physical etching is preferably also used if the second magnetic layer 7 is a hard-magnetic layer.

The rest layer 7r obtained in one of the methods described above preferably has a thickness of up to 5 nm maximum. During the method according to the invention, the rest layer 7r is exposed to oxidation in this embodiment so as to increase the electrical resistance of the relevant layer. The rest layer 7r is then converted into an oxide layer 7R which comprises Ni and Fe oxides in this example; see Fig. 1E. When using nitridation, a nitride layer 7R is obtained. In this example, thermal oxidation or plasma oxidation is preferably used for this conversion. By depositing an insulating material such as  $\text{SiO}_2$ , a protective layer 11 may be formed on the oxidation layer 7R. The shielding layer 9 may be removed.

The magnetic field sensor according to the invention, shown in Fig. 2, comprises a magnetic tunnel junction device 20 of the type shown in Fig. 1E. In this embodiment, the sensor also comprises a magnetic yoke 22 which has an interruption 22a which is bridged and is in magnetic contact with the tunnel junction device 20. The magnetic yoke 22 is formed from a soft-magnetic material such as an NiFe alloy. The sensor has a sensor face 24 adjacent to a non-magnetic transducing gap 26. The interruption 22a and the gap 26 are formed by insulating layers of, for example  $\text{SiO}_2$  or  $\text{Al}_2\text{O}_3$ .

It is to be noted that the invention is not limited to the embodiments shown. For example, variants of the several steps of the method are possible within the scope of the invention. Furthermore, the sensor shown may be formed as a magnetic head for scanning a magnetic recording medium. Such a construction may form part of a combined read/write head. The magnetic tunnel junction device obtained in accordance with the method of the invention may also form part of a magnetic memory.

## CLAIMS:

1. A method of manufacturing a magnetic tunnel junction device, in which a stack comprising two magnetic layers and a barrier layer extending in between is formed, characterized in that one of the magnetic layers is structured by means of etching, in which, during etching, a part of the relevant layer is made thinner by removing material until a rest  
5 layer remains, whereafter the electrical resistance of the rest layer is increased by chemical conversion.

2. A method as claimed in claim 1, characterized in that the chemical conversion is effected by oxidation and/or nitridation.

3. A method as claimed in claim 1, characterized in that physical etching is performed.

4. A method as claimed in claim 1, characterized in that the magnetic layer to be  
15 structured is built up from, consecutively, a basic layer and a layer structure comprising at least a further layer for magnetic pinning of the basic layer.

5. A method as claimed in claims 3 and 4, characterized in that, prior to physical etching, the layer structure is chemically etched until the basic layer is reached.

6. A method as claimed in claim 2, characterized in that an oxidation of the rest layer is effected by thermal oxidation, plasma oxidation or UV-assisted oxidation.

7. A method as claimed in claim 2, characterized in that a nitridation of the rest  
25 layer is effected by thermal nitridation or plasma nitridation.

8. A magnetic tunnel junction device obtained by means of the method as claimed in any one of the preceding claims.



9. A magnetic tunnel junction device as claimed in claim 8, in which the layer other than the structured magnetic layer comprises a soft-magnetic layer which is usable as a flux guide.

10. A magnetic field sensor provided with the magnetic tunnel junction device as claimed in claim 8.

11. A magnetic field sensor as claimed in claim 9, provided with a magnetic yoke which is in magnetic contact with the soft-magnetic layer of the magnetic tunnel junction device.

12. A magnetic memory provided with the magnetic tunnel junction device as claimed in claim 8.

## ABSTRACT:

A method of manufacturing a magnetic tunnel junction device, in which a stack (1) comprising two magnetic layers (3, 7) and a barrier layer (5) extending in between is formed. One of the magnetic layers is structured by means of etching, in which, during etching, a part of this layer is made thinner by removing material until a rest layer (7r) remains. This rest layer is passivated by chemical conversion. In the relevant method, it is prevented that the magnetic layer which is not to be structured is detrimentally influenced during structuring of the other magnetic layer.

Fig. 1E

1/2

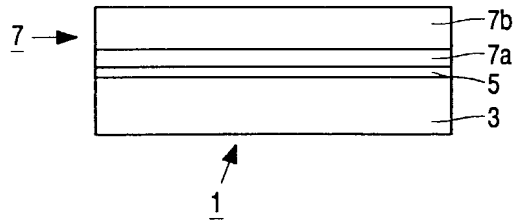


FIG. 1A

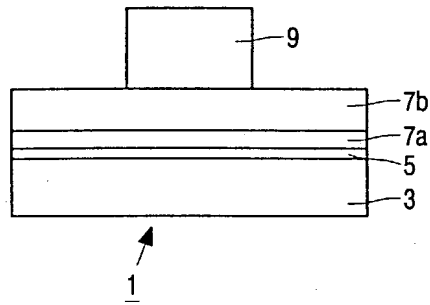


FIG. 1B

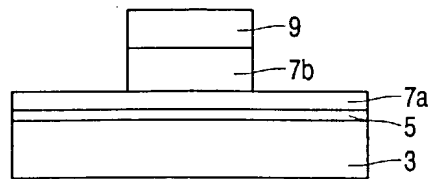


FIG. 1C

2/2

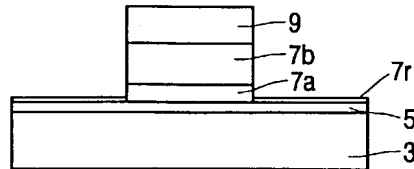


FIG. 1D

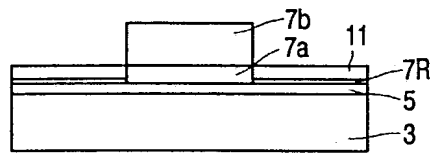


FIG. 1E

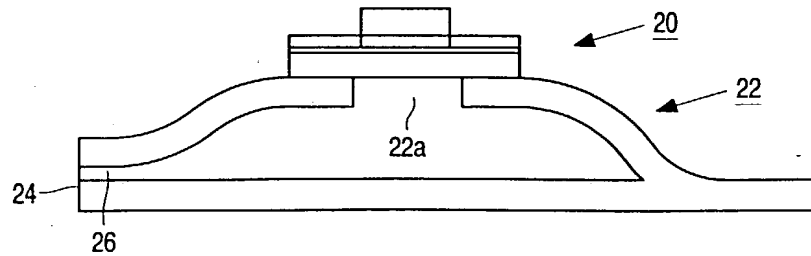


FIG. 2

**COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY**  
(includes Reference to PCT International Applications)

ATTORNEY'S DOCKET  
NUMBER  
**PHN 17.556 US**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **"Method of manufacturing a magnetic tunnel junction device"**  
the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No \_\_\_\_\_

on \_\_\_\_\_

and was amended

on \_\_\_\_\_

☒ was filed as PCT international application

Number PCT/EP00/06816

on 17 July 2000

and was amended under PCT Article 19

on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

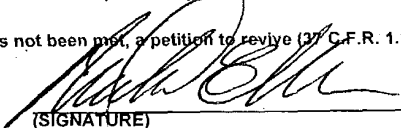
I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

**PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:**

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Europe	99202418.2	22 July 1999	YES

U.S. DEPARTMENT OF COMMERCE -Patent and Trademarks Office  
(July 1994)

532 Rec'd PCT/PTO 19 MAR 2001

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) <b>09/787457</b>		INTERNATIONAL APPLICATION NO. PCT/EP00/00347- <b>EP0006816</b>		ATTORNEY'S DOCKET NUMBER PHN 17,285	
17 [X] The following fees are submitted: BASIC NATIONAL FEE (37 C.F.R. 1.492(A)(1)-(5)):				CALCULATIONS (PTO USE ONLY)	
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TOTAL FEES ENCLOSED =				\$1,010.00	
				Amount to be refunded	\$
				charged	\$
a. [ ] A check in the amount \$_____ to cover the above fees is enclosed. b. [X] Please charge my Deposit Account No. 14-1270 in the amount of <u>\$1,010.00</u> to cover the above fees. A duplicate copy of this sheet is enclosed. c. [X] The Commissioner is hereby authorized to charge any additional fee, with the exception of the Base Issue Fee, which may be required, or credit any overpayment to Deposit Account No. 14-1270. A duplicate copy of this sheet is enclosed.					
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SEND ALL CORRESPONDENCE TO:					
Corporate Patent Counsel Philips Electronics North America Corporation 580 White Plains Road Tarrytown, NY 10591					
DATE OF MAILING: <u>MARCH 19, 2001</u>				(SIGNATURE)  Michael E. Marion NAME 32,266 (REGISTRATION NUMBER)	

Combined Declaration For Patent Application and Power of Attorney (Continued)  
(includes Reference to PCT International Applications)

Attorneys Docket Number  
**PHN 17.556 US**


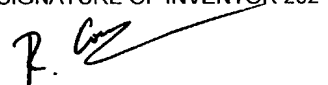
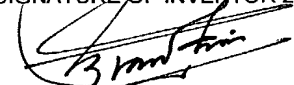
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

Algy Tamoshunas Reg. No. 27,677  
Jack E. Haken, Reg. No. 26,902

Direct Telephone Calls to:  
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	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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DATE 15 February 2001	DATE 15 February 2001	DATE 15 February 2001
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	
DATE	DATE	

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